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THE EFFECT OF THE MID-ATLANTIC RIDGE ON LONG RANGE SOUND PROPAG--ETC(U)
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NUSC Technical Document 6555
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The Effect of the Mid-Atlantic Ridge on Long Range Sound Propagation .

A Paper Presented at the 101st Meeting of the
Acoustical Society of America, 20 May 1981,
Ottawa, Canada

R. F. LaPlante
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Preface

This document was prepared under the sponsorship of the Undersea Warfare Technology Office, Naval Sea Systems Command, under NUSC Project No. A65005, "Ambient Noise Characteristics," NAVSEA Program Manager, F. J. Romano, NUSC Principal Investigator, D. G. Browning.

Reviewed and Approved: 1 October 1981

A handwritten signature in black ink, appearing to read 'Derek Walters', with a long horizontal flourish extending to the right.

**Derek Walters
Surface Ship Sonar Department**

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER TD 6555	2. GOVT ACCESSION NO. AD-A205-747	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) THE EFFECT OF THE MID-ATLANTIC RIDGE ON LONG RANGE SOUND PROPAGATION, A Paper Presented at the 101st Meeting of the Acoustical Society of America, 20 May 1981, Ottawa, Canada		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) R. F. LaPlante, P. D. Koenigs, and D. G. Browning		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Underwater Systems Center New London Laboratory New London, CT 06320		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS A65005
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Sea Systems Command Washington, DC 20362		12. REPORT DATE 1 October 1981
		13. NUMBER OF PAGES 12
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION / DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block numbers) Long Range Sound Propagation Acoustic Propagation		
20. ABSTRACT (Continue on reverse side if necessary and identify by block numbers) This document contains the oral and visual presentation given at the 101st Meeting of the Acoustical Society of America, 20 May 1981, Ottawa, Canada. Previous long range acoustic experiments show that the Mid-Atlantic Ridge, a major topographic feature rising to the deep sound channel axis, can have a significant effect on SOFAR propagation. (R. J. Urlick, J. Acoust. Soc. Am. 35(9), 1413, 1963.) In order to quantify this effect, data have been		

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analyzed from a recent SOFAR experiment that deployed SUS charges during several transits across the Ridge. The signals were received on a hydrophone located near Bermuda, a distance of approximately 2500 km. These results are compared with data from Atlantic seamounts of similar height and ridges in other oceans. (K. M. Guthrie, J. Acoust. Soc. Am., 68(S1), S52(A), 1980.) The enhancement or shadowing of SOFAR propagation is presented as a function of source depth and frequency for various geometries.

The Effect of the Mid-Atlantic Ridge on Long Range Sound Propagation

Introduction

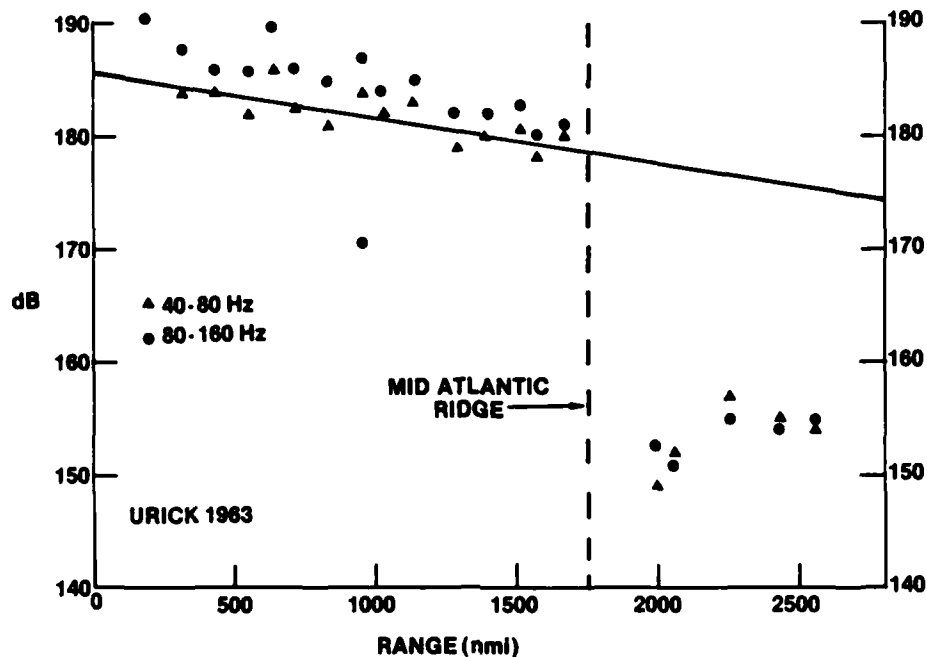
Previous long range acoustic propagation experiments have shown that the Mid-Atlantic Ridge, the major topographic feature in the Atlantic Ocean, can have a significant blocking effect on SOFAR channel propagation. Here, we present an analysis of data obtained from a long range acoustic propagation experiment where the source tracks crossed back and forth over the Mid-Atlantic Ridge. Additionally, these data are compared to those of similar experiments where the acoustic tracks crossed seamounts and major bathymetric rises. Finally, some conclusions and implications of the results are presented.

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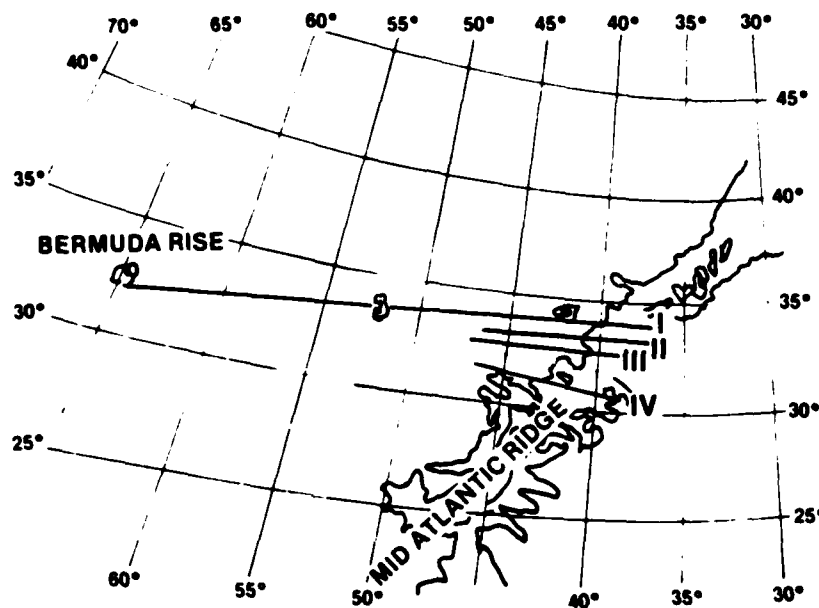


Slide 1

Here we see data presented by Urick in 1963 for a propagation experiment whose track crossed the Mid-Atlantic Ridge. The receiver was located at the sound channel axis in the vicinity of Bermuda. Aircraft-deployed SUS charges were detonated at the axis depth along a track extending from Bermuda, eastward, passing over the Ridge at a range of 1800 nautical miles and continuing to a maximum range of greater than 2500 nautical miles. In both octave bands shown, there is an abrupt 20 to 30 dB decrease in adjusted received level after the Ridge is encountered. This acoustic blockage is just one of the effects that the Ridge has on propagation.

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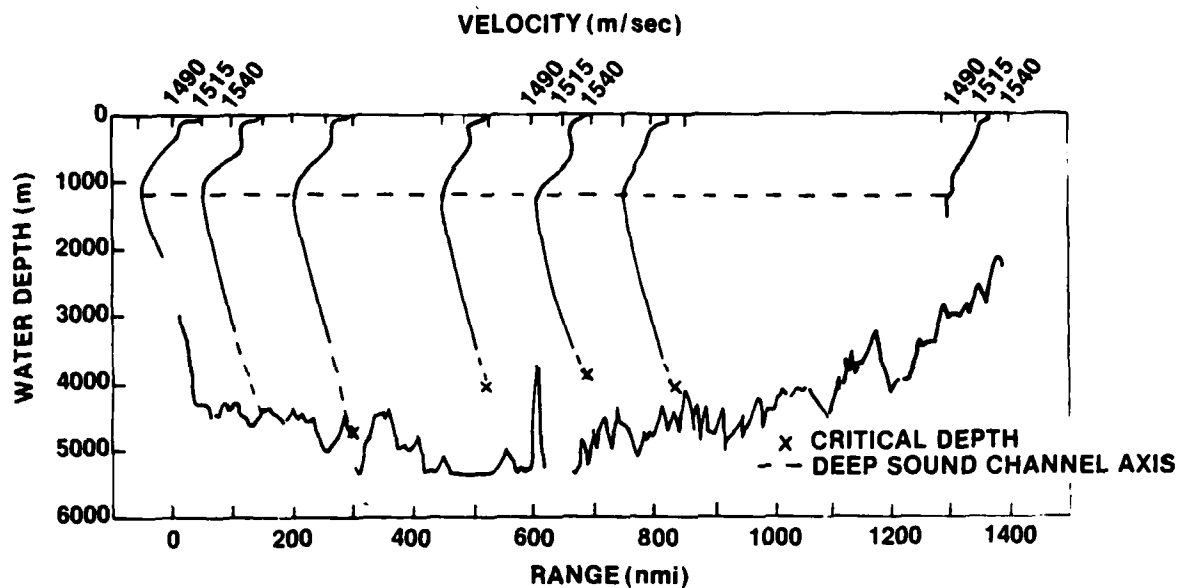
SOURCE SHIP TRACKS (I-IV)



Slide 2

In order to investigate the effects of the Ridge on propagation for near surface sources, an acoustic experiment was conducted under summer conditions where the source ship covered the tracks shown here. Track I ran eastward from Bermuda some 1400 nautical miles crossing the peak of the Mid-Atlantic Ridge. From there, three more traverses of the Ridge were made over tracks II, III, and IV. A major bathymetric feature, the Rockaway Seamount, was encountered at about 600 nautical miles along track I. Explosive sources at both 18-meter and 154-meter depths were detonated at equal intervals over all tracks. The resulting signals were received on a hydrophone in the Bermuda area located close to the deep sound channel axis at a depth of approximately 1400 meters.

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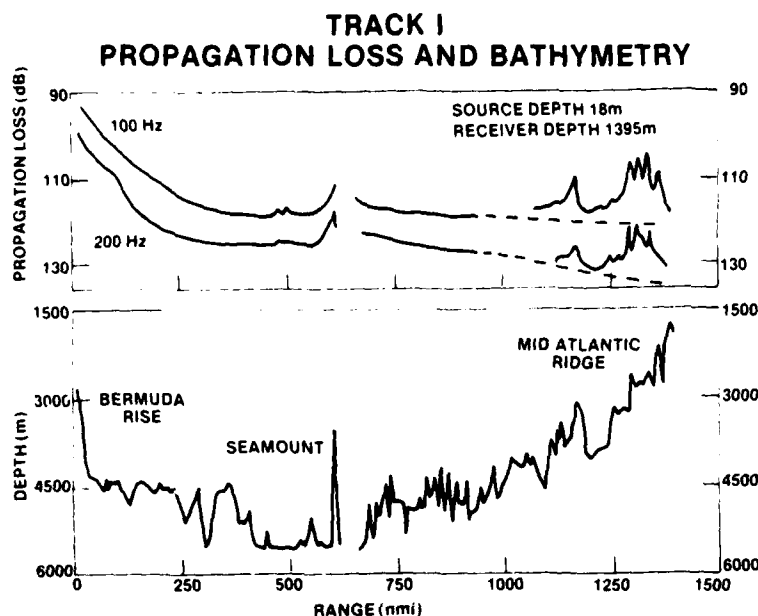


TRACK I BATHYMETRY AND SOUND SPEED STRUCTURE

Slide 3

Here we see the sound velocity structure and bathymetry along track I. The dashed line indicates the axis of the deep sound channel while the X's depict the critical depth along the track. Depth excess generally exists over most of the track except notably at the Rockaway Seamount at 600 nautical miles and as the rise of the Mid-Atlantic Ridge is encountered. In this summertime experiment, no surface duct existed.

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Slide 4

We present our data as propagation loss curves as a function of range with the corresponding bathymetry. The first results are for the 18 meter sources at both 100 Hz and 200 Hz along track I. For ease of presentation, the 200 Hz propagation loss curve has a 5 dB offset of additional loss.

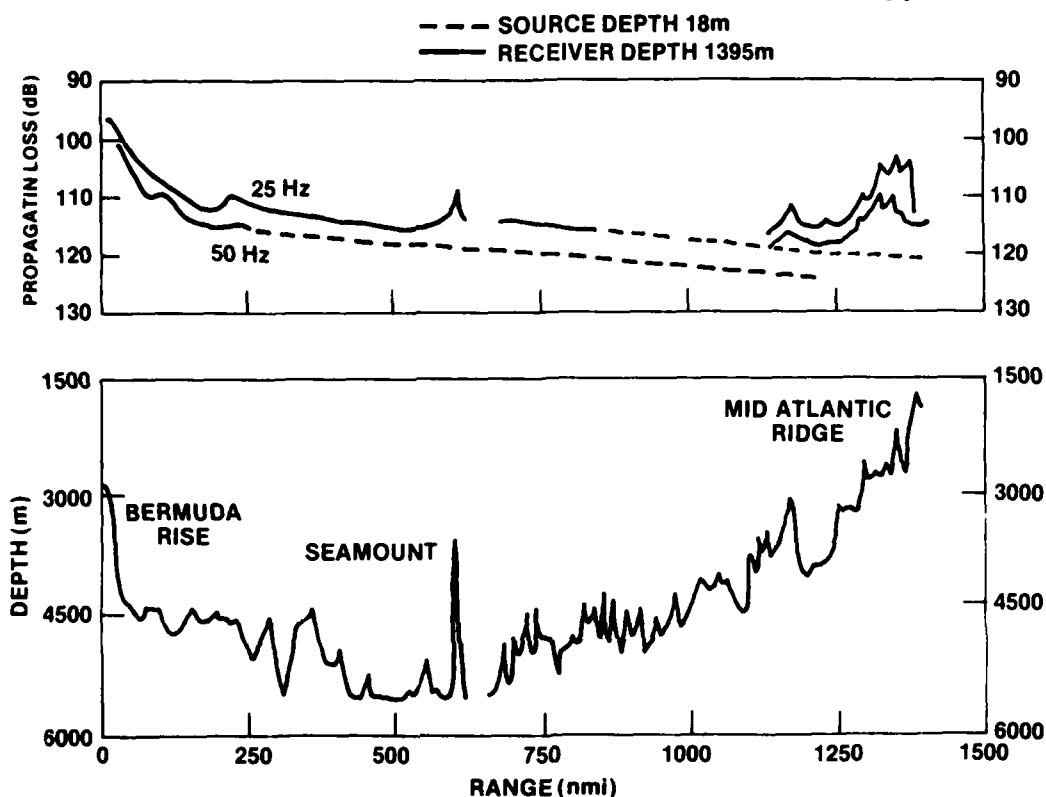
The first feature to note is the enhancement in received level of about 8 dB as the Rockaway Seamount is encountered at about 600 nautical miles. This effect appears to be about equal at both frequencies. Note also that the same value of propagation loss had been observed at about 200 nautical miles or only one-third of the way to the seamount.

The discontinuity in the loss curves after the seamount is due to a small gap in the source track and not because of a shadowing effect.

Continuing in range from the Seamount, we start to see the effects of the various peaks that comprise the ridge. It should be pointed out that the dashed lines are extrapolations of normal propagation loss. The first prominence of the ridge to have an enhancing effect is the peak at about 1200 nautical miles. Here the enhancement is about 10 dB at 100 Hz while only about 5 dB at 200 Hz. As we continue along in range, we see that the enhancement is indeed due to the individual peaks (or on this scale the microstructure) of the ridge and not necessarily from the general slope of the ridge. The maximum enhancement for 100 Hz is about 17 dB and for 200 Hz is about 12 dB. Again, we should note that the loss experienced at 100 Hz at a range of 1300 nautical miles is the same as that experienced when the source was at a range of only a little over 100 nautical miles. The start of the shadowing effect as the peak of the ridge is passed is evident at the far right of the figure.

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TRACK I PROPAGATION LOSS AND BATHYMETRY

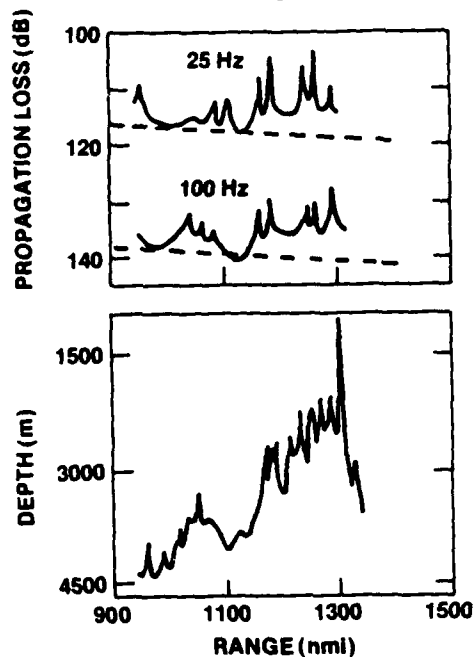


Slide 5

Here we present the 25 Hz and 50 Hz data for the same track. The 50 Hz curve is offset by an additional 5 dB of loss. Effects similar to the 100 Hz and 200 Hz data are again noted at the Rockaway Seamount at 25 Hz and for both frequencies along the rise to the Mid-Atlantic Ridge peak. The shadowing effect of the ridge peak can also be seen.

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TRACK III PROPAGATION LOSS AND BATHYMETRY 18m SOURCE DEPTH



Slide 6

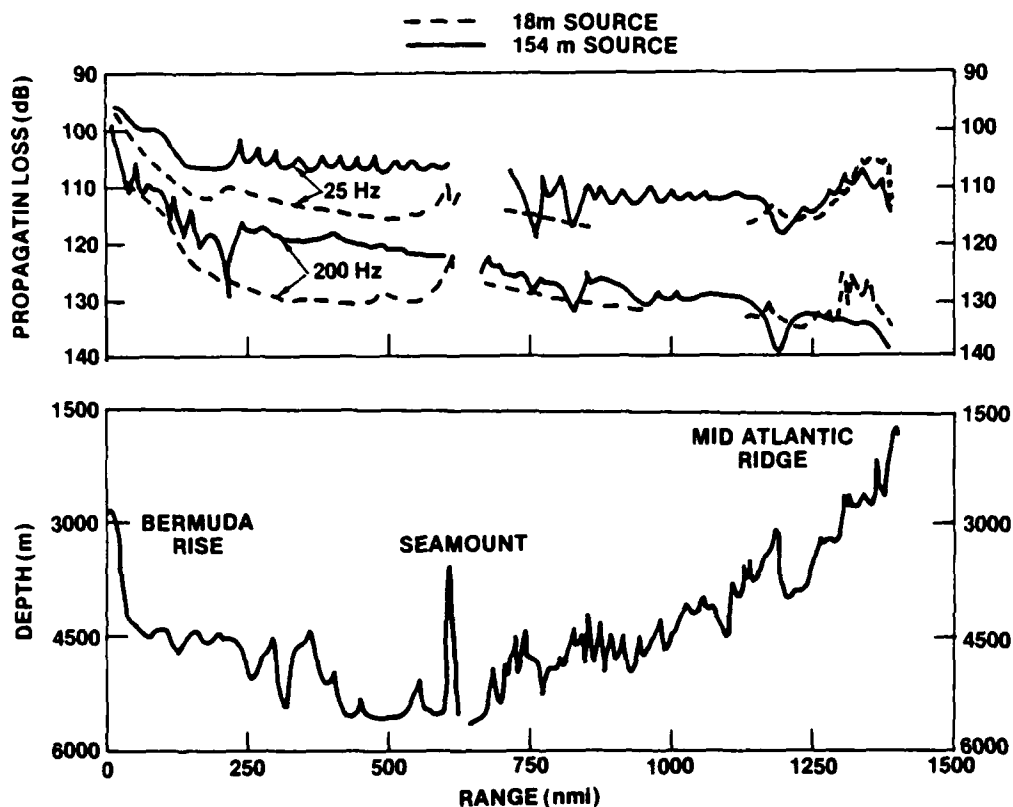
This figure is representative of tracks II, III, and IV. The 100 Hz curve is offset by 20 dB of additional loss for ease of presentation. It can be seen here that although both frequencies exhibit the enhancement features, the particular peaks that affect enhancements may be different for each frequency. The peak in bathymetry at approximately 1050 nautical miles has an obvious enhancement effect on the 100 Hz values, but not nearly so for the 25 Hz values.

Some peaks affect both frequencies while others just affect one frequency or the other.

The maximum enhancements observed here are of the same magnitude as those for track-I and correspond to the loss experienced when the source was at a range of only about 100 nautical miles.

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TRACK I PROPAGATION LOSS AND BATHYMETRY

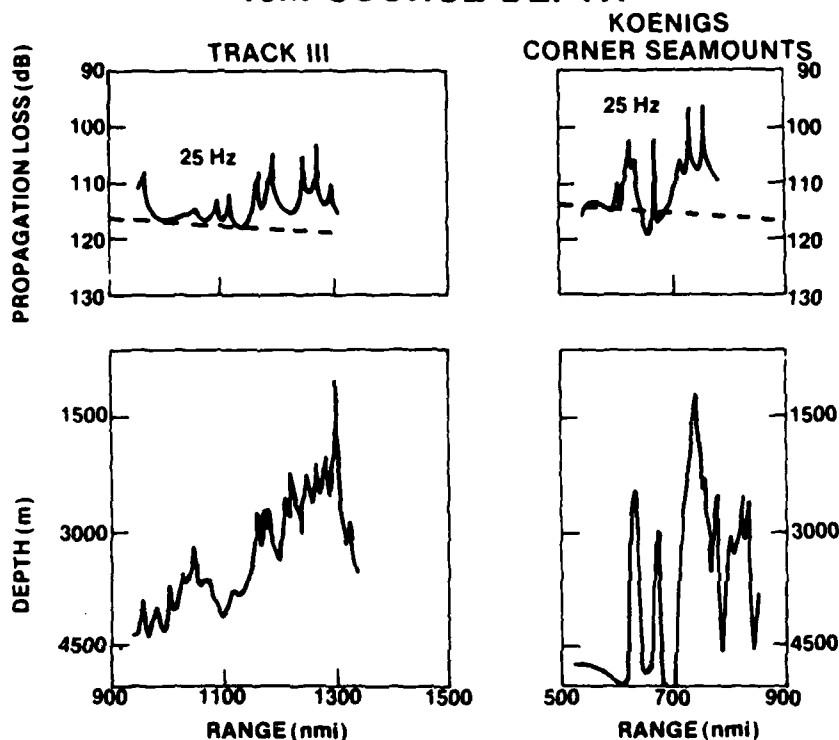


Slide 7

Here is a comparison of the 18-meter source losses with those for the 154-meter source. The solid line depicts the losses for the 154-meter source while the dashed lines depict the propagation loss for the 18-meter source. Both 200 Hz values are offset by an additional 10 dB of loss. The deeper source, although experiencing less loss over most of the track, due to a better coupling with the channel, does not exhibit as much enhancement as the shallow source does due to the bathymetric features, namely the Rockaway Seamount and the Mid-Atlantic Ridge. No effect due to Rockaway Seamount is noted at all for the deeper source while at 200 Hz, the shallow source even exhibits a significantly higher received level in the ridge enhanced region.

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PROPAGATION LOSS AND BATHYMETRY 18m SOURCE DEPTH

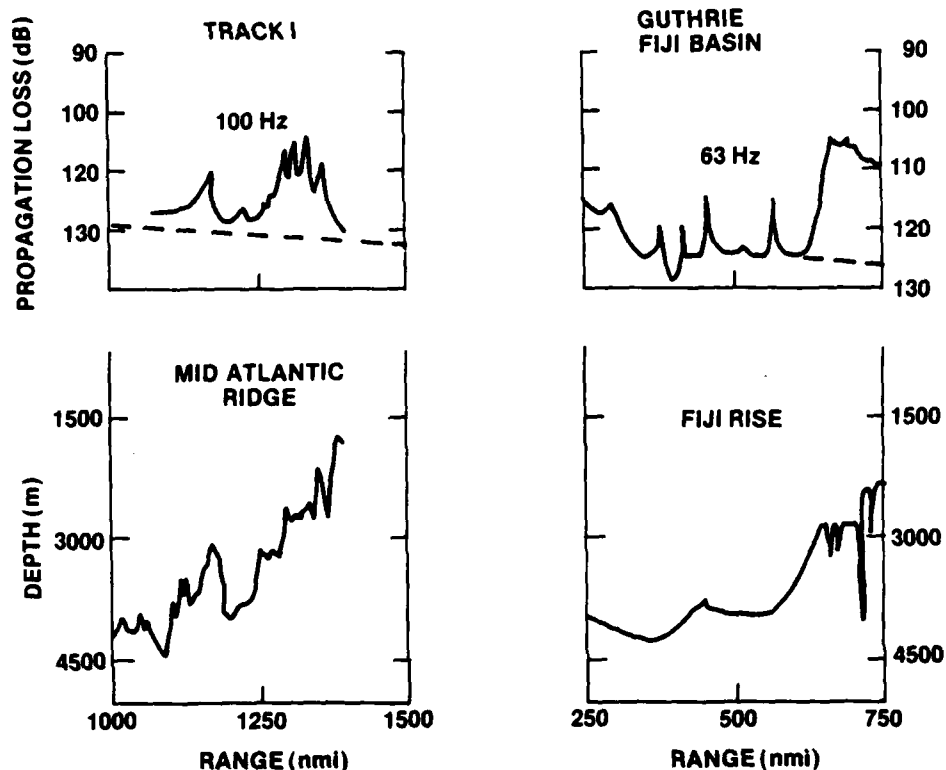


Slide 8

Having observed the significant received signal enhancements due to the bathymetric features of the Mid-Atlantic Ridge, we sought to compare our results with those obtained by others for different bathymetric features. On the left is the enhancement observed for our data for the Mid-Atlantic Ridge while on the right is that observed by Koenigs et al. (NUSC TD 6523, 12 August 1981) for a track that crossed the corner seamounts. Again, it should be noted that the enhancements observed are of about the same magnitude and also seem highly dependent on the slopes of the individual peaks or microstructure of the bathymetry. Note the different ranges for each data set.

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PROPAGATION LOSS AND BATHYMETRY 18 m SOURCE DEPTH



Slide 9

Here we see a side-by-side comparison of our data to Guthrie's (that was presented at the 1977 ASA meeting at Penn State) from an experiment whose track encountered the Fiji Rise, which is similar to the continental slope.

Our data are for 100 Hz and covers the range interval 1000 to 1400 nautical miles while the Guthrie data are for 63 Hz and covers the range interval 250 to 750 nautical miles. Note on the Guthrie data that the loss experienced at about 650 nautical miles are 10 dB less than that experienced with the source at a range of 250 miles. Again, the agreement between data sets is excellent with enhancements in both cases being about 20 dB.

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SUMMARY

- RIDGE CAN HAVE SIGNIFICANT ENHANCEMENT AS WELL AS SHADOW EFFECTS
- SLOPE, HEIGHT OF RIDGE, DEPTH AND FREQUENCY OF SOURCE ARE IMPORTANT FACTORS
- GOOD AGREEMENT WITH SIMILAR MEASUREMENTS
- FACTOR IN AMBIENT NOISE

Slide 10

In summary, you have seen that the Mid-Atlantic Ridge can have significant enhancement on received signals as well as the well known shadow effect.

The degree of enhancement is a function of both the slope and height of the bathymetric prominences that comprise the ridge as well as being a function of the frequency and depth of the source. Bottom loss, of course, also plays an important role.

We have shown good agreement with the degree of enhancement noted for the Mid-Atlantic Ridge measurements compared to both seamount and continental rise or shelf affected measurements.

And finally, as pointed out by Wagstaff in a recent journal article, the contribution to the deep ocean ambient noise levels may be influenced more by ships transiting over distant bathymetric prominences than by nearby shipping itself.

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Thank you. Are there any questions?

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